Weight Gain Prevention and Smoking Cessation: Cautionary Findings

ABSTRACT

Objectives. Weight gain is a consistent sequela of smoking cessation. A successful intervention might attract smokers who fear weight gain. If the gain causes smoking relapse, such an intervention might reduce smoking relapse risk.

Methods. Using a sample of 158 smokers who completed a 2-week smoking treatment program, we compared an innovative weight gain prevention intervention with both a nonspecific treatment and standard treatment. Subjects were assessed on weight and smoking behavior and followed for 1 year.

Results. A disturbing, unexpected finding was that subjects in both the innovative and nonspecific conditions had a higher risk of smoking relapse than did standard treatment subjects. Some differences were observed between abstinent and smoking subjects in weight gain by treatment condition.

Conclusions. Both active interventions may have been so complicated that they detracted from nonsmoking. Also, caloric restriction may increase the reinforcing value of nicotine, a psychoactive drug, thereby increasing smoking relapse risk. The magnitude of weight gain after smoking cessation may not merit interventions that increase smoking risk. Perhaps attitudinal modifications are the most appropriate. (*Am J Public Health.* 1992;82: 799–803)

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Introduction

Weight gain is a consistent sequela of smoking cessation. Of 43 studies of weight change after smoking initiation or cessation, 37 (86%) report that initiation of smoking reduces weight and cessation increases it. The cause of the relationship between smoking cessation and weight gain is unknown although changes in both metabolism and food intake are implicated. Smokers, especially young women who smoke, are aware of nicotine's weight-suppressing effects.[1] Nevertheless, studies of the effects of weight gain on relapse sometimes report surprising findings. For example, investigators[2–4] have found that weight gain during early abstinence predicted long-term abstinence, not relapse.

A successful intervention for weight gain prevention might attract smokers who fear weight gain and could potentially reduce relapse. In those few cases in which weight gain would be sufficient to pose a medical problem, such an intervention would prevent increased risk.

We designed an innovative intervention based on a model that suggests that adherence to behavioral prescriptions is facilitated by simplicity and by a close fit between self-management techniques and the problem behavior.[5] In this study, we report a comparison of this intervention with nonspecific and standard treatment conditions. The nonspecific condition was equivalent to the innovative condition in time and therapeutic attention. The standard treatment control condition was designed to represent standard care of cessation-induced weight gain.

We proposed the following hypotheses: (1) Abstinent smokers in the innovative intervention would gain less weight than those in the nonspecific intervention, who would gain less weight than abstinent smokers in the standard treatment control condition. (2) Abstinence rates in the innovative intervention would be greater than those in the nonspecific intervention or in standard treatment because the close fit of the therapeutic techniques to cessation-induced gain in the innovative condition would be less likely to interfere with abstinence.

We also examined activity levels and, in a subsample, changes in food intake to determine whether subjects adhered to the instructions in the interventions.

Methods

Subjects and Personnel

Subjects were 49 male and 131 female smokers, all of whom met at least one of two risk factors for weight gain: they had to have smoked at least 10 cigarettes per day in the past week or been at least 10% above ideal weight at their maximum.[2] We excluded potential subjects with cardiovascular or pulmonary disease, diabetes, hospitalization for major mental illness within the last year, or any chronic condition that would influence eating or activity levels. Of these 180 subjects, 165 (92%) completed the smoking cessation treatment and were randomized to one of the weight gain prevention interventions.

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There were four female therapists. Two, a master's-level social worker and a doctoral-level psychologist, treated 159 (88%) of the subjects. The other two therapists were a master's-level health educator and a master's-level psychologist. Before beginning the intervention, therapists led at least one training group and observed other therapists' groups. During the intervention, therapists followed a detailed procedures manual. Two female registered dietitians and a male exercise consultant also participated.

Assessments

Assessments were held at pretreatment, at week 2 (the end of smoking treatment), at week 6 (the end of the weight gain prevention intervention), and at weeks 12, 26, and 52 from study start. At each assessment, subjects reported the average number of cigarettes smoked per day in the past week and provided expired air carbon monoxide samples to verify abstinence. At pretreatment and at the week 52 assessment, blood cotinine levels were determined as well. During each assessment week, subjects monitored their activity levels by recording time spent in bouts of activity on a schedule of 49 activities developed from McArdle, Katch, and Katch.[6] Body weights were taken at all assessments on the same balance beam scale. Twenty-four-hour dietary recalls, later processed for nutrient analyses by Nutrition and Diet Services,[7] were obtained from the last 91 subjects to enter the study. At baseline, subjects indicated the number of times they had attempted to quit smoking, their weight gain during past attempts, and whether they were concerned about and expected weight gain during the current attempt.

Procedure

Subjects were randomly assigned, within their time constraints, to groups of five to eight participants. During weeks 1 to 2, all groups received a smoking treatment program of seven 1½-hour sessions that combined aversive smoking and relapse prevention skill training. Until the last smoking treatment session, both therapist and group members were blind to which weight gain prevention intervention the group was assigned.

Subjects assigned to the innovative and nonspecific interventions participated in five weight gain prevention sessions held during weeks 3 to 6. During these sessions, discussions of purely smoking-related phenomena were minimized to focus on weight gain prevention and to keep about equal the amount of time spent on smoking cessation in the three conditions. Other than the assessment at week 6, no meetings were held in the standard treatment condition during these 4 weeks.

Innovative Intervention. There were three components to this intervention.

1. Daily monitoring of weight and contingent caloric reduction. Before the first session of the intervention, the dietitian computed for each subject a calorie level (the "food plan") designed to result in a weight loss of 2 lb per week based on body weight, age, sex, and activity level. The dietitian discussed healthy food choices and provided tips on low-calorie, sweet-tasting foods and on low-fat alternatives to common foods. Subjects weighed themselves each morning without clothing. If their weight was within 2 lb of baseline weight, they ate whatever they liked; if they gained 2 lb or more, they were to use their food plan until baseline weight was achieved.

2. Individualized exercise plan. The exercise consultant explained the principles of aerobic exercise and the benefits of fitness, and he helped subjects select an activity. Subjects were encouraged to exercise three or more times a week at an aerobic level.

3. Behavioral self-management principles. The subjects discussed triggers that resulted in uncontrolled eating. If appropriate, new responses were role-played. Subjects were asked to limit eating to one place at home and at work, and to slow eating by taking a single bite at a time.

Nonspecific Control. The nonspecific control condition included the elements of a credible weight gain prevention intervention without the specific elements of the innovative condition. The nonspecific elements were (1) a rationale based on gaining insight into eating styles, (2) a structured program based on insight-oriented discussion, (3) nutritional and exercise information, (4) group support, and (5) therapeutic attention. The sessions centered around both self-tests adapted from the Smokers' Self-test Kit[8] and informational presentations by the nutritionists and the exercise consultant. The dietitian presented general nutritional information about calories and good nutrition, noting that caloric reduction was necessary for weight loss. The fitness consultant presented fitness principles and the health benefits of exercise. However, there was no attempt to individualize the information. The therapist did not give specific behavioral prescriptions. Rather, she encouraged subjects to decide how they would use feedback provided by the group, and she referred questions about specific techniques back to the group. The number and spacing of sessions were the same as those in the innovative condition.

Standard Treatment Control. Subjects received an information packet on good nutrition and exercise at the last smoking treatment session. This material was not targeted for smoking cessation–induced weight gain.

Results

Preliminary Analyses

As previously noted, 165 of the 180 subjects who began treatment completed the smoking cessation portion. Dropouts did not differ from the rest of the sample in age, gender, ethnicity, level of education, socioeconomic status, number of previous quit attempts, cessation-induced weight gain, pretreatment carbon monoxide, cigarette intake, or body weight. The data from one subject of each pair of six close relatives were randomly selected to use in the data analyses. Data from an additional subject who was later diagnosed as bulimic were discarded. Resultant sample size was 158. Sizes by intervention condition were innovative intervention, 53; nonspecific control, 51; and standard treatment control, 54. When asked if they expected to gain weight after quitting, 112 of these 158 subjects (71%) said yes. One hundred thirty-eight (87%) reported at least one earlier quit attempt, 86 of whom (62%) reported a weight gain that averaged 6.35 kg (SD = 3.86 kg). Almost all the subjects (92%) were concerned about gaining weight when they quit.

Treatment conditions were compared on the same demographic, smoking, and weight history variables used to compare treatment completors and dropouts, as well as on postcessation body weight and postcessation cigarette smoking rates (see Table 1). Only two differences emerged. First, conditions differed on mean number of cigarettes reported smoked per day during the pretreatment week ($F[2,155] = 5.06$, $P < .01$). Subjects in standard treatment smoked significantly more cigarettes than did those in the other two conditions. Second, the three conditions had significantly different variances on pretreatment body weight ($P < .01$). Subjects in the innovative condition had a significantly greater variance in both these measures than did subjects in the nonspecific condition. In tests of the hypotheses, these variables—pretreat-

ment smoking rate and pretreatment body weight—were used as covariates in preliminary analyses if they correlated with the dependent variable, and they were dropped if they did not explain significant proportions of variance or have significant interactions with independent variables. Due to a lack of significant main effects, or interactions, these variables were ultimately dropped from all analyses, except those of abstinence status. No differences due to therapists were found when the main effects of therapist on smoking rate or body weight were examined.

Abstinence Status

At each assessment, subjects were coded as abstinent if they reported no cigarettes smoked during the prior week and had a carbon monoxide level below 10.5 ppm at the assessment. At week 52, subjects were coded as abstinent only if their blood cotinine levels were also less than 50 ng/mL. Chi-squares of abstinence status by treatment condition did not reach significance at any assessment (Table 2).

However, treatment conditions differed at baseline on number of cigarettes smoked, and baseline number of cigarettes did correlate with abstinence status at the followup assessments. The prototypical analysis was a multiple logistic regression with gender and number of cigarettes smoked at pretreatment as covariates. The dependent variable was abstinence status at each assessment week. Subjects with missing data were coded as smoking. These analyses indicated that, at weeks 6, 12, 26, and 52, treatment condition contributed significantly to the abstinence rate. Subjects in the two active interventions had a greater risk of smoking than did subjects in the control condition. Effects for the two active treatment conditions did not differ from one another.

The odds ratios, associated confidence intervals (CIs), and probability levels are shown in Table 3. The nonspecific condition differed significantly ($P \leq .05$) from the control condition at weeks 6, 12, and 52; the innovative condition differed significantly from the control at week 26. The combined active treatment conditions differed significantly from the control at each assessment.

Smoking more than 35 cigarettes per day at pretreatment significantly increased the risk of relapse at all assessments. The odds ratio ranged from 2.73 at week 6 (95% CI = 1.64, 4.57; $P < .001$) to 1.95 at week 52 (95% CI = 1.08, 3.52; $P < .03$). There were no significant effects for gender at any assessment.

TABLE 1—Demographic and Descriptive Data by Treatment Condition

Variable	Innovative Condition (n = 53)	Nonspecific Condition (n = 51)	Standard Treatment Condition (n = 54)
Age, y			
Mean	40.68	41.22	39.24
SD	8.71	8.96	8.92
Cigarettes per day			
Mean	25.65	24.91	31.59
SD	12.56	10.80	11.74
Pretreatment body weight, kg			
Mean	72.68	69.23	67.65
SD	17.72	12.38	12.51
Postcessation treatment body weight, kg			
Mean	73.82	69.98	67.97
SD	18.12	10.48	12.37
Gender			
Male	12 (23%)	17 (33%)	14 (26%)
Female	41 (77%)	34 (67%)	40 (74%)
Ethnicity			
Caucasian	48 (91%)	45 (88%)	50 (91%)
Other	5 (9%)	6 (12%)	4 (9%)

TABLE 2—Number and Percent Abstinent in Each Treatment Condition at Each Assessment

	Innovative Condition (n = 53)		Nonspecific Condition (n = 51)		Active Conditions Combined (n = 104)		Control Condition (n = 54)	
Assessment	n	%	n	%	n	%	n	%
Week 6	26	50	21*	41	47	45	31	57
Week 12	17	32	14*	25	31*	30	24	44
Week 26	11*	21	13	25	24	23	19	35
Week 52	11*	21	11	22	22*	21	19	35

*Comparison with control, $.05 < P < .10$.

Weight Change

The heterogeneity of variances in the weight data was not correctable by either logarithmic or square root transformations. We used a series of Kruskal-Wallis nonparametric analyses of variance on body weight change from week 2 to week 6 and to week 52 to determine if subjects differed by conditions and abstinence status. Kruskal-Wallis tests were also used to establish the lack of difference between conditions and smoking versus nonsmoking subjects on weight change from week 0 to week 2.

There were no differences among treatment conditions on weight change at either week 6 or week 52. Abstinent subjects differed from smoking subjects at both week 6 ($\chi^2[1] = 10.85$, $P < .01$; abstinent subjects, n = 78, mean = +0.79 kg, SD = 1.74; smoking subjects, n = 74, mean = +0.14 kg, SD = 1.32) and week 52 ($\chi^2[1] = 7.21$, $P < .01$; abstinent subjects, n = 31, mean = +2.59 kg, SD = 3.76; smoking subjects, n = 87, mean = +0.22 kg, SD = 3.42). Differences between abstinent and smoking subjects were not consistent across the three conditions, however. In the innovative condition, abstinent and smoking subjects did not differ at either week 6 (abstinent subjects, n = 26, mean = +0.08 kg, SD = 2.4; smoking subjects, n = 24, mean = 0.14 kg, SD = 1.26) or week 52 (abstinent subjects, n = 10, mean = +0.86 kg, SD = 3.95; smoking subjects, n = 35, mean = –0.31 kg, SD = 3.57). Differences between abstinent and smoking subjects were found in the nonspecific condition at both week 6 ($\chi^2[1] = 8.66$, $P < .01$; abstinent subjects, n = 21, mean = +1.20 kg, SD = 1.18; smoking subjects, n = 27, mean = +0.03

TABLE 3—Odds Ratios (ORs),[a] Confidence Intervals (CIs), and Probability Levels for the Two Active Conditions (Separately and Combined) vs the Standard Treatment

	Week 6				Week 12				Week 26				Week 52			
	OR	95%	CI	P	OR	95%	CI	P	OR	95%	CI	P	OR	95%	CI	P
Innovative vs Control	1.48	.89	2.45	.13	1.57	.95	2.60	.08	1.70	1.00	2.88	.05	1.59	.92	2.75	.10
Nonspecific vs Control	2.19	1.28	3.73	.01	2.05	1.19	3.52	.01	1.61	.93	2.79	.08	2.02	1.13	3.64	.02
Combined vs Control	1.76	1.12	2.77	.01	1.77	1.13	2.77	.03	1.66	1.04	2.63	.02	1.77	1.09	2.88	.02

[a]In the present study, the odds ratio is interpreted as the change in risk of relapse to smoking that is attributable to membership in the innovative or nonspecific condition, as compared with membership in the standard treatment control.

kg, SD = 1.39) and week 52 ($\chi^2[1] = 4.12$, $P < .04$; abstinent subjects, n = 7, mean = +3.35 kg, SD = 2.38; smoking subjects, n = 25, mean = +0.44 kg, SD = 3.60). The standard treatment control showed no differences at week 6 ($\chi^2[1] = 1.40$, $P < .29$; abstinent subjects, n = 31, mean = +1.12 kg, SD = 1.54; smoking subjects, n = 23, mean = +0.55 kg, SD = 1.27). However, differences in this condition approached significance at week 52 ($\chi^2[1] = 3.45$, $P < .06$; abstinent subjects, n = 14, mean = +3.61 kg, SD = 3.99; smoking subjects, n = 27, mean = +0.71 kg, SD = 3.09).

Calories and Activity Levels

Of the original subsample of 91 subjects on whom we attempted to collect nutritional data, 68 (75%) completed dietary recalls at every assessment and were therefore included in the repeated measures analyses of caloric intake. These subjects did not differ from either the whole sample or the sample of 91 on whom we attempted to collect data on cigarettes smoked or body weight.

An unacceptable level of heterogeneity of variances in baseline caloric intake was reduced to an acceptable level by a square root transformation. The major analysis was a repeated measures analysis of variance. The dependent variables were the square root transformation of caloric intake at baseline and at weeks 6, 12, 26, and 52. Independent variables were gender, treatment condition, and abstinence status at week 52.

A significant effect for treatment condition over time ($F[8,224] = 3.90, P < .001$) was found, as was a significant abstinence status × treatment condition × time interaction ($F[8,224] = 2.04$, $P < .05$). We found significant treatment effects at week 6 ($F[2,15] = 11.95$, $P < .01$) and week 26 ($F[2,15] = 2.92$, $P < .01$) but not at baseline, week 12, or week 52. At week 6, subjects in the innovative condition ate significantly fewer calories than those in the nonspecific condition ($t[42] = 2.48$, $P < .03$; innovative condition, mean = 1687 cal, SD = 707; nonspecific condition, mean = 1810 cal, SD = 604) and those in the standard treatment control ($t[42] = 4.29$, $P < .01$; mean = 2817 cal, SD = 976). Differences in caloric intake between the nonspecific treatment condition and the standard treatment control were not significant ($t[46] = 1.83$, $P < .10$). At week 26, none of the paired comparisons was significant.

For subjects smoking at week 52, the time × treatment condition interaction was significant ($F[8,164] = 2.77$, $P < .01$). There were also significant treatment condition × gender interactions at baseline ($F[2,41] = 3.65$, $P < .04$), explained primarily by significantly greater caloric intake by men in the innovative condition than by subjects of either gender in any of the five other gender-treatment condition groupings. Repeated measures analysis of variance indicated no significant effect for activity level.

Discussion

The higher smoking rates at follow-up in the two conditions that received an active treatment are troubling. The odds ratios for the risk of smoking for the two active treatment conditions combined were consistently and significantly greater than the odds ratios for the control condition at each assessment after week 2. The most likely explanation for this is that both interventions were sufficiently complicated so that subjects' attempts to apply them detracted from attempts to maintain abstinence. A second explanation is that the caloric reduction encouraged by both active conditions encouraged smoking. Caloric restriction may increase the reinforcing value of psychoactive drugs in laboratory animals.[9]

The failure to find a significant difference between abstinent and smoking subjects in the innovative condition suggests that this condition prevented weight gain, especially when this lack of difference is compared with the significant differences found between abstinent and smoking subjects in the nonspecific condition. Differences in the control condition, however, also failed to reach significance, rendering interpretation tentative. In the innovative condition there was evidence of early compliance with dietary instructions, especially among women and abstinent subjects. The interventions had no measurable affect on self-reported activity.

The limitations of this study are important. First, the results obtained apply to one program; other programs may be more successful. Second, the finding of increased relapse rates in the two active treatment conditions must be viewed with caution. The design of the study, in which differing combinations of behavioral therapists, nutritionists, and exercise therapists treated subjects in each condition, did not lend itself to a thorough analysis of intervenor × treatment condition interaction effects. These effects are known to influence the magnitude of differences among treatment conditions, at least in traditional analysis of variance models.[10] So far as we could find, nothing has been published about these effects in logistic models. Inspection of the data and those analyses we did perform did not suggest consistent intervenor effects, and significant main effects for intervenors were not found. Such analyses, however, cannot substitute for a complete factorial analysis of their differences.

Finally, it should be noted that the average gain for ex-smokers over 1 year is about 4 lb greater than that expected for continuing smokers. One study reported that about 3% of quitters gained 20 lb or more.[11] Such small weight gains do not appear to merit interventions that are extensive or entail risk. Perhaps attitude

changes about weight gain are more appropriate interventions than treatment of that gain. □

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